

Dawood Public School
Course Outline 2018-19
Physics
Class XI

Books:

Pople, S. 2001. Fundamental Physics, GCSE edition, Oxford University Press

Chew, C. et al. 2000. GCE 'O' Level Physics (2 ed), Singapore; Marshal Cavendish Education

Introduction:

This syllabus provides a comprehensive set of progressive learning objectives for Physics.

It has been designed to support students in becoming:

- **confident** in working with information and ideas – their own and those of others
- **responsible** for themselves, responsive to and respectful of others
- **reflective** as learners, developing their ability to learn
- **innovative** and equipped for new and future challenges
- **engaged** intellectually and socially, ready to make a difference.

Cambridge O level Physics

Syllabus Code 5054

All candidates enter for **three** papers – Papers 1 and 2 and 4.

Paper 1	Multiple Choice	1 hour
40 compulsory multiple choice questions of the direct choice type. The questions involve four response items.		
40 marks		

Paper 2	Theory	1 hour 45 minutes
This paper has two sections:		
Section A has a small number of compulsory, structured questions of variable mark value. 45 marks in total are available for this section.		
Section B has three questions. Each question is worth 15 marks. Candidates must answer two questions from this section.		
There is no compulsory question on Section 25 of the syllabus (Electronics systems). Questions set on topics within Section 25 appear only in Paper 2 and are always set as an alternative within a question. Candidates will answer on the question paper.		
75 marks		

Paper 4	Alternative to Practical	1 hour
A written paper of compulsory short-answer and structured questions designed to test familiarity with laboratory practical procedures.		
Candidates will answer on the question paper.		
30 marks		

Syllabus Aims and Assessment:

Aims:

The aims of the science curricula are the same for all students. These are set out below and describe the educational purposes of an O Level/School Certificate course in Physics. They are not listed in order of priority.

1. provide, through well-designed studies of experimental and practical science, a worthwhile educational experience for all candidates, whether or not they go on to study science beyond this level and, in particular, to enable them to acquire sufficient understanding and knowledge
 - 1.1 to become confident citizens in a technological world, able to take or develop an informed interest in matters of scientific import;
 - 1.2 to recognise the usefulness, and limitations, of scientific method and to appreciate its applicability in other disciplines and in everyday life;
 - 1.3 to be suitably prepared for studies beyond Cambridge O Level in pure sciences, in applied sciences or in science-dependent vocational courses.

2. develop abilities and skills that
 - 2.1 are relevant to the study and practice of science;
 - 2.2 are useful in everyday life;
 - 2.3 encourage efficient and safe practice;
 - 2.4 encourage effective communication.

3. develop attitudes relevant to science such as
 - 3.1 concern for accuracy and precision;
 - 3.2 objectivity;
 - 3.3 integrity;
 - 3.4 enquiry;
 - 3.5 initiative;
 - 3.6 inventiveness.

4. stimulate interest in and care for the local and global environment.

5. promote an awareness that:
 - 5.1 the study and practice of science are co-operative and cumulative activities, that are subject to social, economic, technological, ethical and cultural influences and limitations;
 - 5.2 the applications of sciences may be both beneficial and detrimental to the individual, the community and the environment.

Assessment objectives:

The assessment objectives describe the knowledge, skills and abilities that students are expected to demonstrate at the end of the course. They reflect those aspects of the aims that are assessed.

AO1 Knowledge with understanding

Students should be able to demonstrate knowledge with understanding in relation to:

1. scientific phenomena, facts, laws, definitions, concepts, theories;
2. scientific vocabulary, terminology, conventions (including symbols, quantities and units);

3. scientific instruments and apparatus, including techniques of operation and aspects of safety;
4. scientific quantities and their determination;
5. scientific and technological applications with their social, economic and environmental implications.

The subject content defines the factual knowledge that candidates may be required to recall and explain.

Questions testing these objectives will often begin with one of the following words: define, state, describe, explain or outline.

AO2 Handling information and solving problems

Students should be able – using visual, aural and written (including symbolic, diagrammatic, graphical and numerical) information – to:

1. locate, select, organise and present information from a variety of sources, including everyday experience;
2. translate information from one form to another;
3. manipulate numerical and other data;
4. use information to identify patterns, report trends and draw inferences;
5. present reasoned explanations for phenomena, patterns and relationships;
6. make predictions and hypotheses;
7. solve problems.

These assessment objectives cannot readily be fully specified in the syllabus content. Questions testing skills in physics may be based on information (given in the question paper) that is unfamiliar to the students or is based on everyday experience. In answering such questions, students are required to use principles and concepts that are within the syllabus and to apply them in a logical manner. Questions testing these objectives will often begin with one of the following words: predict, suggest, calculate or determine

AO3 Experimental skills and investigations

Students should be able to:

1. follow instructions;
2. carry out techniques, use apparatus, handle measuring devices and materials effectively and safely;
3. make and record observations, measurements and estimates with due regard to precision, accuracy and units;
4. interpret, evaluate and report upon observations and experimental data;
5. identify problems, plan and carry out investigations, including the selection of techniques, apparatus, measuring devices and materials;
6. evaluate methods and suggest possible improvements.

Weighting of assessment objectives

Theory papers (Papers 1 and 2)

AO1 Knowledge with understanding is weighted at approximately 65% of the marks for each paper, with approximately half allocated to recall.

AO2 Handling information and solving problems is weighted at approximately 35% of the marks for each paper.

Practical assessment (Papers 3 and 4)

This is designed to test appropriate skills in assessment objective AO3 and will carry approximately 20% of the marks for the qualification.

EXAMINERS TIPS for O level Physics 5054

How to Use These Tips:

These tips highlight some common mistakes made by students. They are collected under various subheadings to help you when you revise a particular topic.

General Advice

- There is no escaping it; thorough and careful revision is the best way to prepare for a physics examination.
- Make your revision productive by making it interesting and fun. Make notes, revision cards or mind maps. Revision should be an active process, i.e. you should be 'doing things', not just sitting and reading a book.
- Do not try to learn it all in one go! Take regular breaks and review what you have learnt regularly.
- Learning equations is essential; put them on small pieces of paper and stick them somewhere you will see them every morning.
- Revise with a friend so you can test each other or try explaining the physics of a topic to a friend – as if you were a teacher!
- Working through past paper questions is the best way to complete your revision. This helps you to know the type and style of questions to expect in the examination.
- Try timed questions so you can learn to answer quickly.
- Get your answers checked so you know you are correct!

Spelling

The spelling of technical terms is important, so make sure your writing is legible as well as spelt correctly. Some words are very similar, such as reflection and refraction, fission and fusion. If the examiner cannot tell which one you have written, then you will lose the mark. Make a list of technical terms and definitions in each section of the syllabus, checking the spellings carefully.

General Tips

In O Level Physics examinations you have to be able to complete a variety of tasks; always read the question carefully to make sure you have understood what you are expected to do. In descriptive answers, you should:

- check the number of marks available and make sure you give sufficient points.
- plan your answer first so that you don't repeat yourself or contradict yourself.
- read your answer through carefully afterwards to check you have not missed out important words.
- use sketches and diagrams wherever you can to help your explanation.
- add labels when referring to a diagram, e.g. point X, so that you can refer to it easily in your explanation. This can save many words and much confusion.
- In numerical answers, you should:
 - quote any **formulae** you are going to use and show **clearly all the steps** in your working. It may be tempting to use your calculator and just write down the answer; but if you write down one figure wrongly then you may lose all the marks for the calculation. If the examiner can see the formula and the numbers you have used then you will lose only a

little credit. Some questions ask for a formula to be quoted; even if you get the right answer, failure to quote the formula will lose you a mark.

- check the units are consistent, e.g. if the distance is given in km and the speed in m/s, then you must convert the km to m.
- be careful when you are converting minutes and seconds: 1 minute 30 seconds is not 1.3 minutes and 150 seconds is not 1.5 minutes. These are common mistakes, so always double check any conversion of units of time.
- state the answer clearly at the end.
- give your answer as a decimal to an appropriate number of significant figures. Don't leave your answer as a fraction unless specifically asked to do so.
- check that you have given the **unit** of your final answer.
- look at your final answer and see that it is reasonable. If you have calculated the cost of using an electrical appliance such as a kettle for a few minutes and found it to be hundreds of dollars, then check the powers of ten in your calculation.
- Plotting graphs can be tested in Papers 2, 3 or 4.
- When drawing graphs, you should:
 - remember to label the axes with both quantity (e.g. distance or d) and unit (e.g. metres or m). Then write it as distance / metres or even just d / m .
 - make sure the axes are the correct way round. You are usually told, for example, to plot distance on the x -axis, so make sure you know that x is the horizontal axis!
 - make the scales go up in sensible amounts, i.e. not 0, 3, 6... or 0, 7, 14 ... but 0, 5, 10 ... or 0, 2, 4
 - make sure that the plotted points fill at least half the graph paper. This means if you can double the scale and still plot all the points then you should double the scale
 - check if you have been told to start the scales from the origin. If not, then think carefully about where to start the axes.
 - use a sharp pencil to plot the points and draw the line.
 - plot the points carefully. It is best to use small neat crosses. Every point will be checked by the marker, and you will lose the mark if any are wrongly plotted.
 - draw either a straight line or a smooth curve. In physics we never join the dots!
 - remember that a best fit line (curve or straight) should have some points above and some points below the line.
- When taking readings from a graph, you should:
 - draw a large triangle when measuring the gradient of a line. It must be at least half the length of the line. Examiner's tip – draw a triangle the full size of the graph! It is best to show the numbers on the sides of the triangle when finding the gradient,
 - always use points on the line, not your plotted points, when calculating the gradient.
 - draw a tangent to find the gradient of a curve. Make sure it is at the right place on the curve. Again, use a large triangle.
 - make sure you read the scales correctly when reading a value from a graph. It may be that they are in mA rather than A or km rather than m.
- When describing the shape of a graph, remember that:
 - directly proportional means a straight line through the origin. In this case, doubling one quantity will cause the other to double; alternatively if two quantities F and L are directly proportional then if you find several values of F/L they should be the same.
 - if the straight line does not go through the origin, then it is just called a linear graph.
 - if doubling one quantity causes the other to halve, then they are inversely proportional.
 - if increasing one quantity causes the other to decrease, it is called an inverse relationship.

Paper 1 Tip - Multiple Choices

When reading the question, you should:

- read the question carefully. If you know you tend to jump to a quick conclusion, cover up the answers while you read the stem of the question.
- avoid rushing the questions. Some will be very quick to answer, others take more time.
- check whether a positive or negative answer is being asked for, i.e. does the question say “which of the following is or is not ...?” For example, when asked for an incorrect ray diagram it is easy to pick a correct diagram as your answer.
- underline or circle important information in the stem of the question to help you understand the important points.
- never leave a question unanswered; marks are not deducted for incorrect answers.
- try to eliminate some of the possible answers if you are not sure of the answer.
- write out your working to numerical questions clearly (on the question paper, near the question) so you can check it later.
- be aware of the topics which occur frequently, such as potential difference and potential dividers. The theory here just has to be learnt!
- When taking readings from a diagram, you should:
- check you are using the correct distance; for example in moments questions, remember you need to use the perpendicular distance from the force to the pivot.
- draw on the diagram to help you understand what is happening; for example in deciding the direction of the magnetic field at a point near a bar magnet, draw in the shape of the field.
- Choosing the right response:
- When several answers seem correct, re-read the stem of the question. You must choose the answer that is not only a correct statement, but also answers the question; for example swapping the live and neutral wires in a plug is a fault, but will not cause the fuse to blow.
- The live wire touching the metal case of a kettle is a fault which will cause the fuse to blow!
- Choosing the right equation:
- Many equations are very similar, e.g. $E = mc^2$ (energy equivalence of mass) and $E = \frac{1}{2} mv^2$
- (Kinetic energy) so make sure you know when to use each one.

Paper 2 Tips - Structured Questions

- Read all the three questions in section B before you make your choice of which two questions to answer. Some students find it better
 - to read through the whole paper before they start writing any answers at all
 - to start answering section B with the question they think they can answer best.Whatever you do, you must plan your answers to section B briefly, perhaps writing brief notes
 - but be sure to **include all the material** you want to be marked in the correct place on your script.
- Read all the parts of a question before you start. It is often tempting to write too much in the first part and then realise you have answered the second and third parts as well but in the wrong place.
- Only answer the question asked. Don't be tempted to give more detail than is required. This wastes time and gains you no extra marks!
- If you are asked for two points (e.g. name two materials that are magnetic ...) then don't give three. If you give three and one is incorrect, you will only get one mark out of two.
- Your answer should fit the space available. If it doesn't, you are writing too much! The number of lines given is a clue as to how much to write. Practise the size of your writing: if it

is too big, it will not fit in the space; if it is too small, then the examiner will not be able to read it.

- Failure to give enough detail is a common cause of lost marks; for example If the question asks you to describe the movement of electrons, then you must mention electrons; if the direction of the current in a solenoid is reversed, then just saying that the magnetic field changes is not enough - you need to say that the field reverses or changes direction. If you describe the motion of molecules in a liquid then linking the temperature to the average kinetic energy of the molecules is important. Molecules of a gas exert a pressure on the walls of a container by colliding with the walls. Collisions between the molecules themselves do not explain the pressure on the walls. To increase the pressure, molecules can hit the walls harder or more often, i.e. at a greater speed or more frequently. Take care to explain this clearly and without contradiction!
- Make sure you know where to put ammeters and voltmeters in a circuit. Ammeters are in series and voltmeters in parallel with other components. If you need to vary the current, make sure you include a variable resistor or use a variable power supply.
- If the question asks you to “state and explain” you need state the answer then give a clear explanation. The amount of detail depends upon the number of marks.
- Make sure that you link your answer to the question, rather than just quoting learnt facts. For example, just stating that paper stops alpha is not enough if the question asks why a radioactive tracer emitting alpha particles is not used inside the body.
- If you are asked to draw forces on a diagram, draw them through the point where they act.
- Do not draw them floating in mid-air to the side of a diagram! Remember to **label** them. Add an arrow to show the direction, e.g. if the question asks for “the force exerted by the Sun on the Earth”, then since it is a force of attraction, the force arrow must go from the Earth towards the Sun.
- Some incorrect physics statements will lose a mark even if followed or accompanied by a correct statement. Examples of such statements are:
- Renewable energy sources can be used again and again. Use the explanation that there is an infinite supply or renewable energy sources will not run out.
- Heat rises. Note that it is either hot air or hot liquids that rise, carrying the heat energy with them.
- Acceleration at a constant speed. This is a contradiction as if you travel at a constant speed, you cannot be accelerating! When describing uniform acceleration, you can say constant acceleration or accelerating at a constant rate.

General Tips for both Paper 3 & 4 - Practical Test and Alternative to Practical

- When asked to take a single reading, make sure you include the unit.
- Do not write anything you are not asked for – you are not expected to write an account of the experiment unless asked to do so.
- If you are asked to “use your results” to explain something, then quote them, do not just mention the theory you know!
- If you are reading a measuring instrument, give all the values on the scale, e.g. on a hundredth of a second stopwatch, write 9.24 s – not 9 or 9.2 s (and not 09:24 s).
- Significant figures are important in the practical papers. Do not quote too many – or too few!
- Give just the right number. Many marks are lost by giving too few significant figures. This usually occurs when reading a scale where the value is on a major mark, e.g. 6 V. If the scale measures to 0.1 V, then the reading is 6.0 V, and you must include the point zero! There are usually 2 or 3 significant figures in most readings. Think carefully if you ever use more or less.

- In calculated values, you should never give more significant figures than were used in the data, e.g. the average of 27.95, 26.54 and 27.36 is actually 27.28333333 but should be given as either 27.28 to the four significant figures given in the data or 27.3 as the variation of the readings suggests that four significant figures are too many.
- Normally you can measure an instrument to the accuracy shown by the smallest scale division. However
 - If using a liquid in glass thermometer, you should be able to estimate within the degree markings, e.g. to 0.5°C or even 0.25°C.
 - If using a ruler you can usually measure to about 0.3-0.5 mm even though the smallest division is a mm.
- Make sure you understand technical terms used in the question; for example extension means the increase in length of a spring when a load is added; calibration means "to put a scale on a measuring instrument", which applies to any measuring instrument.
- When measuring vertical heights, a set-square should always be used to ensure the ruler is vertical. The set-square can be shown correctly positioned in a diagram.
- Make sure you can explain the difference between the source of error and what you could do to reduce it, e.g. in transferring a hot object from one place to another: the source of error is the heat it loses during the transfer and you could reduce this error by reducing the distance it has to be moved.
- If a question asks for the effect of changing something such as "the length of the wings" then make sure your answer shows a comparison, e.g. "the longer the wings, the longer the time to fall".
- When measuring time or length be careful to explain the meaning clearly; for example "longer" can mean either a longer time or a longer length. There is no confusion if you use the words "a longer time" or "a shorter time".
- When recording your readings in a table:
- Write down **all** your readings clearly. Do not do a calculation in your head or on your calculator without writing the readings down first and saying what they are. Then the examiner can see what you have done and give you the credit you deserve.
- Write both the quantity and unit in the heading. Note that the quantity means current, not "reading on the ammeter". Don't write the unit after every reading in the table which makes it difficult to see the values clearly; a heading should say current / ampere or just I / A.
- You do not need a column labeled "reading number" which just goes 1, 2, 3 etc. If you are given a table outline in which to record your results, this will use one of them and you will not have enough columns for your results.
- Make sure you have taken sufficient readings, e.g. if you are asked to measure the temperature of a cooling liquid for five minutes, then a reading every minute gives you too few readings. Every 30 seconds is acceptable.
- Make sure you record readings that cover the whole range; for example record the temperature for the full time suggested in the question and don't forget to note down the temperature when you start the stopwatch.
- Make sure all the readings of one quantity in a table have the same number of decimal places as these reflect the accuracy of the measuring instrument. Trailing zeros are often missed out.

Paper 4 Tips - Alternative to Practical

This paper asks you questions about how you would perform practical in the laboratory at your school. So you need experience of actual practical not just alternative to practical papers. When you observe your teacher demonstrating experiments, you should:

- watch closely how the apparatus is set up.
- think about any problems with the apparatus that occur during the experiment.
- think about any sources of error in taking the readings.
- when you do practical work at school, you should: handle the apparatus carefully.
- think about how the apparatus is set up.
- ask your teacher for help if you are not sure.
- think about how you take down the readings in a clear table – never just write numbers on a page, as you may well forget what they were later!
- think about the number of significant figures in your readings.
- Answering the examination Paper
- When answering questions about sources of error in an experiment, just writing “more accurate” is usually not enough - more detail is required
- Sometimes the answers appear too obvious, but they are good practical points; .for example
- when choosing a measuring cylinder of the correct size to measure the volume of some marbles, the measuring cylinder must be large enough to hold all the marbles!
- If a question involves familiar equipment used in a novel way, e.g. circuits or ray diagrams:
 - take time to look at the equipment used in the question; do not assume that it is the same as an experiment you have seen before.
 - follow round the circuit or the rays of light to be sure you understand what is happening

Monthly Syllabus

MONTH	CHAPTERS	DURATION
AUGUST	<ul style="list-style-type: none"> • Static Electricity • Current Electricity • D.C. Circuits 	2 Weeks 2 Week
SEPTEMBER	<ul style="list-style-type: none"> • Practical Electricity • Magnetism and Electromagnetism • Electromagnetism • ATP 	2 Weeks 1 Week 1 Week
OCTOBER	<ul style="list-style-type: none"> • Electromagnetism • Electromagnetic Induction • Introductory Electronics • ATP 	1 Week 2 Weeks 1 Week
NOVEMBER	<ul style="list-style-type: none"> • Electronic Systems • REVISION FOR MID TERM EXAMS 	1 Week
DECEMBER	<ul style="list-style-type: none"> • MID TERM EXAMS 	
JANUARY	<ul style="list-style-type: none"> • Radioactivity • The Nuclear Atom • ATP • Past Papers 	2 Weeks 1 Week

FEBRUARY	<ul style="list-style-type: none"> ● Past Papers ● ATP 	
MARCH	<ul style="list-style-type: none"> ● Revision for Mock Examinations ● MOCK EXAMS 	

Syllabus Content:

1. Static Electricity

GCE O Level Physics by Charles Chew, Unit 17, Pg No.(259-274)

Explaining Physics by Stephen Pople, Unit 6.1 – 6.3, Pg No. (230 -241)

Content:

- 1.1 Laws of electrostatics
- 1.2 Principles of electrostatics
- 1.3 Applications of electrostatics

Learning outcomes:

Candidates should be able to:

- (a) describe experiments to show electrostatic charging by friction.
- (b) explain that charging of solids involves a movement of electrons.
- (c) state that there are positive and negative charges and that charge is measured in coulombs.
- (d) state that unlike charges attract and like charges repel.
- (e) describe an electric field as a region in which an electric charge experiences a force.
- (f) state the direction of lines of force and describe simple field patterns.
- (g) describe the separation of charges by induction.
- (h) discuss the differences between electrical conductors and insulators and state examples of each.
- (i) state what is meant by “earthing” a charged object.
- (j) describe examples where charging could be a problem, e.g. lightning.
- (k) describe examples where charging is helpful, e.g. photocopier and electrostatic precipitator.

Enhancement:

- State that charge is measured in coulombs
- State the direction of lines of force and describe simple field patterns, including the field around a point charge and the field between two parallel plates
- Give an account of charging by induction
- Recall and use the simple electron model to distinguish between conductors and insulators

Reference Books:

- Pople, Stephen, Fundamental Physics for Cambridge O level, Oxford University Press; Unit 8.01, 8.03, Pg No.(170– 175)
- Rnold.BrianWoolley.Steve, Long man GCSE Physics Pearson education Ltd, Chap 6, Pg No 48
- Avison.John, The World Of Physics, Thomas Nelson & Sons Ltd; Chap 11, Pg No 202
- Sang, David, Physics 1 & 2, Cambridge University Press
- Duncan, Tom, GCSE Physics, John Murray
- Abbott, A.F., Physics, Heinemann Educational

Learning Resources:

Theatre of Electricity:

www.mos.org/sln/toe/toe.html

Van de Graaf generator:

www.howstuffworks.com/vdg.htm

www.youtube.com/watch?v=sy05B32XTYY

The Gold-Leaf Electroscope:

www.youtube.com/watch?v=5j4piAl_igE

The Basic Law:

www.youtube.com/watch?v=F6v8wm7_vdQ

Types of charge:

www.physicsclassroom.com/class/estatics/u8l1c.cfm

www.youtube.com/watch?v=45AAI9_lsc

Charging by friction:

www.physicsclassroom.com/class/estatics/u8l2a.cfm

www.youtube.com/watch?v=d1RbFxTpn_g

Electric field:

<http://hyperphysics.phy-astr.gsu.edu/hbase/electric/elefie.html>

www.youtube.com/watch?v=WcSSWN4Tnoo

Plotting field patterns:www.physicslab.co.uk/Efield.htm

Electric fields:

www.colorado.edu/physics/2000/waves_particles/wavpart3.html

Electrostatic Induction:

www.s-cool.co.uk/gcse/physics/static-and-current-electricity/revise-it/static-electricity

www.youtube.com/watch?v=U3mxRSTedeY

Conductors and insulators:

www.ndt-ed.org/EducationResources/HighSchool/Electricity/conductorsinsulators.htm

Earthing:

www.youtube.com/watch?v=NK-BxowMlfg

Lightning:

www.fi.edu/weather/lightning/science.html

www.sciencemadesimple.co.uk/page179g.html

Photocopier:

www.bbc.co.uk/schools/gcsebitesize/science/add_gateway_pre_2011/radiation/electrostaticsusesrev1.shtml

Electrostatic precipitator:

www.frankswebpace.org.uk/ScienceAndMaths/physics/physicsGCSE/usingStatic.htm

Electrostatic spraying:

www.youtube.com/watch?v=leapiWpg0Gc

www.slideshare.net/awkf2000/16-static-electricity

2. Current Electricity

GCE O Level Physics by Charles Chew, Unit 18, Pg No.(276-299)

Explaining Physics by Stephen Pople, Unit 6.4 – 6.6, Pg No. (242 -252)

Content

2.1 Current

2.2 Electromotive force

2.3 Potential difference

2.4 Resistance

Learning outcomes

Candidates should be able to:

- (a) state that a current is a flow of charge and that current is measured in amperes.
- (b) do calculations using the equation charge = current \times time.
- (c) describe the use of an ammeter with different ranges.
- (d) explain that electromotive force (e.m.f.) is measured by the energy dissipated by a source in driving a unit charge around a complete circuit.
- (e) state that e.m.f. is work done/charge.
- (f) state that the volt is given by J / C.
- (g) calculate the total e.m.f. where several sources are arranged in series and discuss how this is used in the design of batteries.
- (h) discuss the advantage of making a battery from several equal voltage sources of e.m.f. arranged in parallel.
- (i) state that the potential difference (p.d.) across a circuit component is measured in volts.
- (j) state that the p.d. across a component in a circuit is given by the work done in the component/charge passed through the component.
- (k) describe the use of a voltmeter with different ranges.
- (l) state that resistance = p.d./current and use the equation resistance = voltage/current in calculations.
- (m) describe an experiment to measure the resistance of a metallic conductor using a voltmeter and an ammeter and make the necessary calculations.
- (n) state Ohm's Law and discuss the temperature limitation on Ohm's Law.
- (o) *use quantitatively the proportionality between resistance and the length and the cross-sectional area of a wire.
- (p) calculate the net effect of a number of resistors in series and in parallel.
- (q) describe the effect of temperature increase on the resistance of a resistor and a filament lamp and draw the respective sketch graphs of current/voltage.
- (r) describe the operation of a light-dependent resistor.

Enhancement

- Show understanding that a current is a rate of flow of charge and recall and use the equation $I = Q / t$
- Distinguish between the direction of flow of electrons and conventional current
- Show understanding that e.m.f. is defined in terms of energy supplied by a source in driving charge round a complete circuit

- Recall and use quantitatively the proportionality between resistance and length, and the inverse proportionality between resistance and cross-sectional area of a wire

Reference Books

- Pople, Stephen, Fundamental Physics for Cambridge O level, Oxford University Press; Unit 8.04- 8.08, Pg No.(176 – 185)
- Rnold.BrianWoolley.Steve, Long man GCSE Physics Pearson education Ltd; Chap 1,2, Pg No 1
- Avison.John, The World Of Physics, Thomas Nelson & Sons Ltd; Chap 12 , Pg No 220
- Sang, David, Physics 1 & 2, Cambridge University Press
- Duncan, Tom, GCSE Physics, John Murray

Learning Resources:

Electric current:

<http://hyperphysics.phy-astr.gsu.edu/hbase/electric/elecur.html>

www.physicsclassroom.com/class/circuits/u9l2c.cfm

www.bbc.co.uk/schools/ks3bitesize/science/energy_electricity_forces/electric_current_voltage/revise1.shtml

Current and charge:

www.youtube.com/watch?v=A1kT78RRM5Q

<http://physicsnet.co.uk/a-level-physics-as-a2/current-electricity/charge-current-potential-difference/>

Using a multimeter:

www.dNovronics.co.uk/meter.htm

www.youtube.com/watch?v=bF3OyQ3HwfU

Difference between e.m.f and p.d:

www.nuffieldfoundation.org/practical-physics/potential-difference-and-emf

Energy and voltage:

www.bbc.co.uk/bitesize/higher/physics/elect/energy_volts/revision/3/

<http://hyperphysics.phy-astr.gsu.edu/hbase/electric/elevol.html>

P.d:

www.physicsclassroom.com/class/circuits/u9l1c.cfm

www.youtube.com/watch?v=-2epDX0mF4I

3. D.C. Circuits

GCE O Level Physics by Charles Chew, Unit 19, Pg No.(301-309)

Explaining Physics by Stephen Pople, Unit 6.7 – 6.8, Pg No. (253 -261)

Content

3.1 Current and potential difference in circuits

3.2 Series and parallel circuits

Learning outcomes

Candidates should be able to:

- (a) *draw circuit diagrams with power sources (cell, battery or a.c. mains), switches (closed and open), resistors (fixed and variable), light-dependent resistors, thermistors, lamps, ammeters, voltmeters, magnetising coils, bells, fuses, relays, diodes and light-emitting diodes.
- (b) state that the current at every point in a series circuit is the same, and use this in calculations.
- (c) state that the sum of the potential differences in a series circuit is equal to the potential difference across the whole circuit and use this in calculations.
- (d) state that the current from the source is the sum of the currents in the separate branches of a parallel circuit.
- (e) do calculations on the whole circuit, recalling and using formulae including $R = V/I$ and those for potential differences in series, resistors in series and resistors in parallel.

Enhancement

- Recall and use the fact that the sum of the p.d.s across the components in a series circuit is equal to the total p.d. across the supply
- Recall and use the fact that the current from the source is the sum of the currents in the separate branches of a parallel circuit
- Calculate the effective resistance of two resistors in parallel

Reference Books

- Pople, Stephen, Fundamental Physics for Cambridge O level, Oxford University Press; Unit 8.09 -8.10, Pg No.(186– 191)
- Rnold.BrianWoolley.Steve, Long man GCSE Physics Pearson education Ltd; Chap 2, Pg No 13
- Avison.John, The World Of Physics, Thomas Nelson & Sons Ltd; Chap 12, Pg No 236
- Sang, David, Physics 1 & 2, Cambridge University Press
- Duncan, Tom, GCSE Physics, John Murray

Learning Resources:

Several cells in parallel:

www.allaboutcircuits.com/vol_6/chpt_3/3.html

<http://electronics.howstuffworks.com/everyday-tech/battery6.htm>

Potential difference:

www.regentsprep.org/Regents/physics/phys03/apotdif/default.htm

www.bbc.co.uk/schools/gcsebitesize/design/electronics/calculationsrev1.shtml

The Ohm Law:

<http://phet.colorado.edu/en/simulation/ohms-law>

<http://hyperphysics.phy-astr.gsu.edu/hbase/electric/ohmlaw.html>

www.youtube.com/watch?v=uLU4LtG0_hc

Current and voltage:

<http://jersey.uoregon.edu/vlab/Voltage/>

Dependence on length and area:

www.regentsprep.org/Regents/physics/phys03/bresist/default.htm

www.youtube.com/watch?v=R4qFnKnZEOA

Resistors in parallel and series:

<http://schools.matter.org.uk/Content/Resistors/Default.htm>

<http://physics.bu.edu/py106/notes/Circuits.html>

Circuit symbols:

www.gcse.com/circuit_symbols.htm

www.bbc.co.uk/schools/gcsebitesize/science/add_aqa/electricity/circuitsrev1.shtml

p.d.s in series:

www.bbc.co.uk/schools/gcsebitesize/science/add_ocr_pre_2011/electric_circuits/parallelancseriesrev3.shtml

Resistance:

<http://hyperphysics.phy-astr.gsu.edu/hbase/electric/resis.html>

www.physicsclassroom.com/class/circuits/u9l3b.cfm

4. Practical Electricity

GCE O Level Physics by Charles Chew, Unit 20, Pg No.(311-329)

Explaining Physics by Stephen Pople, Unit 6.9 – 6.11, Pg No. (262 -272)

Content

4.1 Uses of electricity

21.2 Dangers of electricity

21.3 Safe use of electricity in the home

Learning outcomes

Candidates should be able to:

- (a) describe the use of electricity in heating, lighting and motors.
- (b) do calculations using the equations $\text{power} = \text{voltage} \times \text{current}$, and $\text{energy} = \text{voltage} \times \text{current} \times \text{time}$.
- (c) calculate the cost of using electrical appliances where the energy unit is the kW h.
- (d) state the hazards of damaged insulation, overheating of cables and damp conditions.
- (e) explain the use of fuses and circuit breakers, and fuse ratings and circuit breaker settings.
- (f) explain the need for earthing metal cases and for double insulation.
- (g) state the meaning of the terms live, neutral and earth.
- (h) describe how to wire a mains plug safely. Candidates will not be expected to show knowledge of the colours of the wires used in a mains supply.
- (i) explain why switches, fuses and circuit breakers are wired into the live conductor.

Enhancement

- Recall and use the equations $P = IV$ and $E = IVt$
- Calculate the cost of using electrical appliances where the energy unit is the kW h.

Reference Books

- Pople, Stephen, Fundamental Physics for Cambridge O level, Oxford University Press; Unit 8.11, 8.14, Pg No.(190– 197)
- Rnold.BrianWoolley.Steve, Long man GCSE Physics Pearson education Ltd; Chap 3, Pg No 23
- Sang, David, Physics 1 & 2, Cambridge University Press
- Duncan, Tom, GCSE Physics, John Murray
- Abbott, A.F., Physics, Heinemann Educational

Learning Resources:

Uses of electricity:

www.youtube.com/watch?v=eUoviiylEmQ

Electrical power:

www.kpsec.freeuk.com/power.htm

www.bbc.co.uk/schools/gcsebitesize/

Fuses and circuit breakers:

<http://hyperphysics.phy-astr.gsu.edu/>

www.gcscience.com/pme9.htm

Electricity bills:

www.gcse.com/energy/kWh5.htm

www.bbc.co.uk/schools/gcsebitesize/

Mains wiring:

www.frankswebpace.org.uk/ScienceAndMaths

Earthing:

www.bbc.co.uk/schools/

www.bbc.co.uk/schools/gcsebitesize/s

Double insulation:

<http://olevelphysicsblog.blogspot.co.uk/2010/12/dangers-of-electricity.html>

Electrical safety: www.youtube.com/watch?v=-lDdGWFBbWI

5. Magnetism and Electromagnetism

GCE O Level Physics by Charles Chew, Unit 21, Pg No.(331-350)

Explaining Physics by Stephen Pople, Unit 7.1 – 7.4, Pg No. (280 -291)

Content

5.1 Laws of magnetism

5.2 Magnetic properties of matter

5.3 Electromagnetism

Learning outcomes

Candidates should be able to:

- (a) state the properties of magnets.
- (b) describe induced magnetism.
- (c) state the differences between magnetic, non-magnetic and magnetised materials.
- (d) describe electrical methods of magnetisation and demagnetisation.
- (e) describe the plotting of magnetic field lines with a compass.
- (f) state the differences between the properties of temporary magnets (e.g. iron) and permanent magnets (e.g. steel).
- (g) describe uses of permanent magnets and electromagnets.
- (h) explain the choice of material for, and use of, magnetic screening.
- (i) describe the use of magnetic materials in audio/video tapes.

- (j) describe the pattern of the magnetic field due to currents in straight wires and in solenoids and state the effect on the magnetic field of changing the magnitude and direction of the current.
- (k) describe applications of the magnetic effect of a current in relays, circuit-breakers and loudspeakers.

Enhancement

- Describe the use of magnetic materials in audio/video tapes.
- Describe the pattern of the magnetic field due to currents in straight wires and in solenoids and state the effect on the magnetic field of changing the magnitude and direction of the current.
- Describe applications of the magnetic effect of a current in relays, circuit-breakers and loudspeakers.
- State the qualitative variation of the strength of the magnetic field over salient parts of the pattern
- Describe the effect on the magnetic field of changing the magnitude and direction of the current

Reference Books

- Pople, Stephen, Fundamental Physics for Cambridge O level, Oxford University Press; Unit 9.01- 9.04, Pg No.(202–209)
- Rnold.BrianWoolley.Steve, Long man GCSE Physics Pearson education Ltd; Chap 4, Pg No 31
- Avison.John, The World Of Physics, Thomas Nelson & Sons Ltd; Chap 14 , Pg No 270
- Duncan, Tom, GCSE Physics, John Murray
- Abbott, A.F., Physics , Heinemann Educational

Learning Resources:

www.zephyrus.co.uk/magneticpoles.html

www.youtube.com/watch?v=IW7BCTQDY_g

www.practicalphysics.org/go/Experiment_313.html?topic_id=7&collection_id=41

Electromagnets:

www.bbc.co.uk/learningzone/clips/electromagnets/289.html

Magnetic tape:

<http://hyperphysics.phy-astr.gsu.edu/hbase/audio/tape2.html>

Uses of magnets:

www.howmagnetwork.com/uses.html

Magnetic Screening:

www.exploratorium.edu/snacks/magshield/

Uses of magnetic screening:

www.magneticshield.com/

www.nuffieldfoundation.org/practical-physics/magnetic-shielding

6. Electromagnetism

GCE O Level Physics by Charles Chew, Unit 22, Pg No. (352-361)

Explaining Physics by Stephen Pople, Unit 7.5 – 7.6, Pg No. (292 -297)

Content

6.1 Force on a current-carrying conductor

6.2 The d.c. motor

Learning outcomes

Candidates should be able to:

- (a) describe experiments to show the force on a current-carrying conductor, and on a beam of charged particles, in a magnetic field, including the effect of reversing (1) the current, (2) the direction of the field.
- (b) state the relative directions of force, field and current.
- (c) describe the field patterns between currents in parallel conductors and relate these to the forces which exist between the conductors (excluding the Earth's field).
- (d) explain how a current-carrying coil in a magnetic field experiences a turning effect and that the effect is increased by increasing (1) the number of turns on the coil, (2) the current.
- (e) discuss how this turning effect is used in the action of an electric motor.
- (f) describe the action of a split-ring commutator in a two-pole, single-coil motor and the effect of winding the coil onto a soft iron cylinder.

Enhancement

- Describe an experiment to show the corresponding force on beams of charged particles
- State and use the relative directions of force, field and current
- Describe the effect of increasing the current

Reference Books

- Pople, Stephen, Fundamental Physics for Cambridge O level, Oxford University Press; Unit 9.04- 9.06, Pg No.(208–213)
- Rnold.BrianWoolley.Steve, Long man GCSE Physics Pearson education Ltd; Chap 5, Pg No 38
- Avison.John, The World Of Physics, Thomas Nelson & Sons Ltd; Chap 15, Pg No 299
- Duncan, Tom, GCSE Physics, John Murray

Learning Resources:

Fields due to currents:

<http://schools.matter.org.uk/Content/MagneticFields/Default.htm>

<http://hyperphysics.phy-astr.gsu.edu/hbase/magnetic/magcur.html>

www.youtube.com/watch?v=3KkOqVEa1oI

Relays:

www.technologystudent.com/elec1/relay1.htm

www.youtube.com/watch?v=qje8LhZXw00

Circuit breakers:

<http://hyperphysics.phy-astr.gsu.edu/hbase/electric/bregnd.html>

The motor effect:

www.bbc.co.uk/schools/gcsebitesize/science/edexcel_pre_2011/electricityworld/thecostofelectricityrev1.shtml

www.cyberphysics.co.uk/topics/magnetsm/electro/Motor%20Effect.htm

www.youtube.com/watch?v=tE8hQJrA_XY

Fleming's left hand rule:

www.s-cool.co.uk/a-level/physics/forces-in-magnetic-fields/revise-it/the-motor-effect-and-flemings-left-hand-rule

www.le.ac.uk/se/centres/sci/selfstudy/mam12.htm

www.youtube.com/watch?v=9Zy0VHBXxLU

Loudspeakers:

<http://hyperphysics.phy-astr.gsu.edu/hbase/audio/spk.html>

www.youtube.com/watch?v=oGrlz6t28XE

Parallel wires:

www.youtube.com/watch?v=43AeuDvWc0k

www.s-cool.co.uk/a-level/physics/forces-in-magnetic-fields/revise-it/force-on-parallel-wires

Torque on coil:

www.youtube.com/watch?v=MosMfPI1MNA

The electric motor:

www.bbc.co.uk/schools/gcsebitesize/science/edexcel_pre_2011/electricityworld/thecostofelectricityrev1.shtml

www.youtube.com/watch?v=pKAb7GCKoWo

7. Electromagnetic Induction

GCE O Level Physics by Charles Chew, Unit 23, Pg No.(363-376)

Explaining Physics by Stephen Pople, Unit 7.8 – 7.11, Pg No. (303 -317)

Content

7.1 Principles of electromagnetic induction

7.2 The a.c. generator

7.3 The transformer

Learning outcomes

Candidates should be able to:

- describe an experiment which shows that a changing magnetic field can induce an e.m.f. in a circuit.
- state the factors affecting the magnitude of the induced e.m.f.
- state that the direction of a current produced by an induced e.m.f. opposes the change producing it (Lenz's Law) and describe how this law may be demonstrated.
- describe a simple form of a.c. generator (rotating coil or rotating magnet) and the use of slip rings where needed.
- *sketch a graph of voltage output against time for a simple a.c. generator.
- describe the structure and principle of operation of a simple iron-cored transformer.
- state the advantages of high voltage transmission.

(h) discuss the environmental and cost implications of underground power transmission compared to overhead lines.

Enhancement

- State the factors affecting the magnitude of an induced e.m.f.
- Show understanding that the direction of an induced e.m.f. opposes the change causing it
- Describe the principle of operation of a transformer
- Recall and use the equation $V_p I_p = V_s I_s$ (for 100% efficiency)
- Explain why energy losses in cables are lower when the voltage is high

Reference Books

- Pople, Stephen, Fundamental Physics for Cambridge O level, Oxford University Press; Unit 9.07-9.12, Pg No. (214–225)
- Rnold.BrianWoolley.Steve, Long man GCSE Physics Pearson education Ltd; Chap 5, Pg No 38
- Avison.John,The World Of Physics, Thomas Nelson & Sons Ltd; Chap 15 , Pg No 310
- Sang, David, Physics 1 & 2, Cambridge University Press
- Duncan, Tom, GCSE Physics, John Murray
- Abbott, A.F., Physics, Heinemann Educational

Learning Resources:

Electromagnetic induction:

<http://micro.magnet.fsu.edu/electromag/java/faraday2/>

www.bbc.co.uk/schools/gcsebitesize/science/add_ocr_pre_2011/electric_circuits/mainsproducedrev1.shtml

https://www.o2learn.co.uk/o2_video.php?vid=405

Lenz's Law:

<http://micro.magnet.fsu.edu/electromag/java/lenzlaw/>

<http://hyperphysics.phy-astr.gsu.edu/hbase/electric/farlaw.html>

www.youtube.com/watch?v=sPLawCXvKmg

www.youtube.com/watch?v=HNmgE0rJ_xk

The a.c. generator:

www.animations.physics.unsw.edu.au/jw/electricmotors.html#mandg

www.youtube.com/watch?v=d_aTC0iKO68

An a.c. supply:

www.bbc.co.uk/schools/gcsebitesize/science/add_aqa_pre_2011/electricity/mainselectrev5.shtml

www.frankswebpace.org.uk/ScienceAndMaths/physics/physicsGCSE/dcac.htm

The transformer:

<http://hyperphysics.phy-astr.gsu.edu/hbase/magnetic/transf.html>

<http://people.clarkson.edu/~svoboda/eta/plots/transformer.html>

Power lines:

www.practicalphysics.org/go/Experiment_352.html

Environmental effects:

www.emfs.info/Sources+of+EMFs/Underground/

Past paper questions:

Nov 12 Paper 21 Q7

Jun 12 Paper 21 Q8

Nov 11 Paper 21 Q6

Nov 11 Paper 22 Q5

Nov 11 Paper 22 Q7

8. Introductory Electronics

GCE O Level Physics by Charles Chew, Unit 24, Pg No.(379-384)

Explaining Physics by Stephen Pople, Unit 8.1 – 8.5, 8.8, Pg No. (324 -340, 349 - 351)

Content

8.1 Thermionic emission

8.2 Simple treatment of cathode-ray oscilloscope

8.3 Action and use of circuit components

Learning outcomes

Candidates should be able to:

- (a) state that electrons are emitted by a hot metal filament.
- (b) explain that to cause a continuous flow of emitted electrons requires (1) high positive potential and (2) very low gas pressure.
- (c) describe the deflection of an electron beam by electric fields and magnetic fields.
- (d) state that the flow of electrons (electron current) is from negative to positive and is in the opposite direction to conventional current.
- (e) describe the use of an oscilloscope to display waveforms and to measure p.d.s and short intervals of time (the structure of the oscilloscope is **not** required).
- (f) explain how the values of resistors are chosen according to a colour code and why widely different values are needed in different types of circuit.
- (g) discuss the need to choose components with suitable power ratings.
- (h) describe the action of thermistors and light-dependent resistors and explain their use as input sensors (thermistors will be assumed to be of the negative temperature coefficient type).
- (i) describe the action of a variable potential divider (potentiometer).
- (j) describe the action of a diode in passing current in one direction only.
- (k) describe the action of a light-emitting diode in passing current in one direction only and emitting light.
- (l) describe and explain the action of relays in switching circuits.
- (m) describe and explain circuits operating as light-sensitive switches and temperature operated alarms (using a relay or other circuits).

Enhancement

- Describe (in outline) the basic structure and action of a cathode-ray oscilloscope
- Use and describe the use of a cathode-ray oscilloscope to display waveforms
- Describe the action of a diode and show understanding of its use as a rectifier
- Describe the action of a transistor as an electrically operated switch and show understanding of its use in switching circuits
- Recognise and show understanding of circuits operating as light sensitive switches and temperature-operated alarms (using a relay or a transistor)

Reference Books

- Pople, Stephen, Fundamental Physics for Cambridge O level, Oxford University Press; Unit 10.07 – 10.08, Pg No.(242–245)
- Rnold.BrianWoolley.Steve, Long man GCSE Physics Pearson education Ltd; Chap 36, Pg No 334
- Avison.John,The World Of Physics, Thomas Nelson & Sons Ltd; Chap 16, Pg No 332
- Sang, David, Physics 1 & 2, Cambridge University Press
- Duncan, Tom, GCSE Physics, John Murray
- Abbott, A.F., Physics, Heinemann Educational

Learning Resources:

Thermionic emission:

www.matter.org.uk/tem/electron_gun/electron_gun_simulation.htm

www.youtube.com/watch?v=pw9c-X6JCdI

Thermionic diodes:

www.nationmaster.com/encyclopedia/Thermionic-valve

www.st-andrews.ac.uk/~jcgl/Scots_Guide/audio/part9/page1.html

Electric field deflection:

<http://physics.bu.edu/~duffy/PY106/Electricfield.html>

Magnetic field deflection:

www.regentsprep.org/Regents/physics/phys03/cdeflecte/default.htm

Negative electrons:

www.kpsec.freeuk.com/electron.htm

C.R.O:

www.nuffieldfoundation.org/practical-physics/using-cro-show-rectification-diode

www.youtube.com/watch?v=0tPEoRSXUIY

C.R.O. settings:

www.kpsec.freeuk.com/cro.htm

Resistor colour code:

www.uoguelph.ca/~antoon/gadgets/resistors/resistor.htm

Thermistors and LDRs:

www.bbc.co.uk/schools/gcsebitesize/s

<http://physicsnet.co.uk/gcse-physics/non-ohmic-devices/>

Thermistors:

www.youtube.com/watch?v=FGt_mAWtV1Q

LDRs:

www.youtube.com/watch?v=Nlkjito8yEA

9. Electronic Systems

GCE O Level Physics by Charles Chew, Unit 24, Pg No. (384-392)

Explaining Physics by Stephen Pople, Unit 8.7, Pg No. (345 -348)

Note: There is no compulsory question set on Section 9 of the syllabus. Questions set on topics within Section 9 are always set as an alternative within a question.

Content

9.1 Switching and logic circuits

9.2 Bistable and astable circuits

Learning outcomes

Candidates should be able to:

- describe the action of a bipolar npn transistor as an electrically operated switch and explain its use in switching circuits.
- state in words and in truth table form, the action of the following logic gates, AND, OR, NAND, NOR and NOT (inverter).
- state the symbols for the logic gates listed above (American ANSI Y 32.14 symbols will be used).
- describe the use of a bistable circuit.
- discuss the fact that bistable circuits exhibit the property of memory.
- describe the use of an astable circuit (pulse generator).
- describe how the frequency of an astable circuit is related to the values of the resistive and capacitive components

Enhancement

- Design and understand simple digital circuits combining several logic gates
- Describe the use of a bistable circuit.
- Describe the use of an astable circuit (pulse generator).
- Describe how the frequency of an astable circuit is related to the values of the resistive and capacitive components.

Reference Books

- Pople, Stephen, Fundamental Physics for Cambridge O level, Oxford University Press; Unit 10.01- 10.06. Pg No. (229–241)
- Rnold.BrianWoolley.Steve, Long man GCSE Physics Pearson education Ltd; Chap 7, Pg No 55
- Avison.John, The World Of Physics, Thomas Nelson & Sons Ltd; Chap 16, Pg No 360
- Duncan, Tom, GCSE Physics, John Murray

Learning Resources:

Logic gates:

www.kpsec.freeuk.com/gates.htm

www.youtube.com/watch?v=fI08wARVDY4

Bistable circuits:

www.sphaera.co.uk/bistable.htm

www.youtube.com/watch?v=0tR5nwfENb4

Astable circuit:

www.bbc.co.uk/schools/gcsebitesize/design/electronics/integratedrev2.shtml

www.youtube.com/watch?v=tJMN5CR6aPw

Past paper questions:

Nov 12 Paper 22 Q7

Nov 11 Paper 21 Q7

Jun 11 Paper 22 Q6

Nov10 Paper 21 Q7

Nov10 Paper 22 Q5

10. Radioactivity

GCE O Level Physics by Charles Chew, Unit 25, Pg No.(395-404)

Explaining Physics by Stephen Pople, Unit 8.9, 8.11-8.12, Pg No. (352 -356, 361 - 369)

Content

10.1 Detection of radioactivity

10.2 Characteristics of the three types of emission

10.3 Nuclear reactions

10.4 Half-life

10.5 Uses of radioactive isotopes including safety precautions

Learning outcomes

Candidates should be able to:

- (a) describe the detection of alpha-particles, beta-particles and gamma-rays by appropriate methods.
- (b) state and explain the random emission of radioactivity in direction and time.
- (c) state, for radioactive emissions, their nature, relative ionising effects and relative penetrating powers.
- (d) describe the deflection of radioactive emissions in electric fields and magnetic fields.
- (e) explain what is meant by radioactive decay.
- (f) explain the processes of fusion and fission.
- (g) describe, with the aid of a block diagram, one type of fission reactor for use in a power station.
- (h) discuss theories of star formation and their energy production by fusion.
- (i) explain what is meant by the term half-life.
- (j) make calculations based on half-life which might involve information in tables or shown by decay curves.
- (k) describe how radioactive materials are moved, used and stored in a safe way.
- (l) discuss the way in which the type of radiation emitted and the half-life determine the use for the material.
- (m) discuss the origins and effect of background radiation.
- (n) discuss the dating of objects by the use of ^{14}C .

Enhancement

- Describe their deflection in electric fields and magnetic fields
- Interpret their relative ionising effects
- Discuss the way in which the type of radiation emitted and the half-life determine the use for the material.

- Discuss the origins and effect of background radiation.
- Discuss the dating of objects by the use of C^{14}

Reference Books

- Pople, Stephen, Fundamental Physics for Cambridge O level, Oxford University Press; Unit 10.01- 10.08, Pg No.(249–265)
- Rnold.BrianWoolley.Steve, Long man GCSE Physics Pearson education Ltd; Chap 32, 33, 34 Pg No 301- 326
- Avison.John, The World Of Physics, Thomas Nelson & Sons Ltd; Chap 18, Pg No 387
- Duncan, Tom, GCSE Physics, John Murray

Learning Resources:

Radioactive safety:

www.bbc.co.uk/schools/gcsebitesize/science/ocr_gateway_pre_2011/living_future/4_nuclear_radiation4.shtml

Detecting radiation:

www.darvill.clara.net/nucrad/detect.htm

www.bbc.co.uk/schools/gcsebitesize/science/aqa_pre_2011/radiation/radioactiverev5.shtml

Cloud chamber:

www.youtube.com/watch?v=ItdSjJKmyDY

Radiation properties:

www.physics.isu.edu/radinf/properties.htm

<http://web.princeton.edu/sites/ehs/osradtraining/radiationproperties/radiationproperties.htm>

Electric field effect:

www.youtube.com/watch?v=ZIFz3AAwwBQ

Magnetic field effect:

www.youtube.com/watch?v=adGVpHvEyUU

Random emission:

www.physicsdaily.com/physics/Random

<http://serc.carleton.edu/quantskills/activities/PennyDecay.html>

www.youtube.com/watch?v=Utpi5rFSVe0

Radioactive decay:

<http://lectureonline.cl.msu.edu/~mmp/applist/decay/decay.htm>

www.bbc.co.uk/schools/gcsebitesize/science/add_aqa_pre_2011/radiation/atomsisotopesrev3.shtml

Fission:

<http://hyperphysics.phy-astr.gsu.edu/hbase/nucene/fission.html>

www.youtube.com/watch?v=kHXMiYsFSrU

www.youtube.com/watch?v=hKhYc9c2Aqs

Nuclear power stations:

www.technologystudent.com/energy1/nuclear1.htm

Background radiation:

www.darvill.clara.net/nucrad/sources.htm

www.bbc.co.uk/schools/gcsebitesize/science/ocr_gateway_pre_2011/living_future/4_nuclear_radiation2.shtml

www.youtube.com/watch?v=TdbzShLU30w

Half-life:

<http://hyperphysics.phy-astr.gsu.edu/hbase/nuclear/halfli.html>

www.bbc.co.uk/schools/gcsebitesize/science/aqa_pre_2011/radiation/radioactiverev7.shtml

www.youtube.com/watch?v=214cwT4v3D8

Half-life calculations:

www.darvill.clara.net/nucrad/hlife.htm

Uses of radiation:

www.bbc.co.uk/schools/gcsebitesize/science/ocr_gateway_pre_2011/living_future/4_nuclear_radiation2.shtml

www.darvill.clara.net/nucrad/uses.htm

www.gcscience.com/prad24-radioactivity-uses.htm

Radiocarbon dating:

www.c14dating.com

<http://archaeology.about.com/od/rterms/g/radiocarbon.htm>

www.youtube.com/watch?v=GfiNewvZA4I

Nuclear fusion:

www.jet.efda.org/pages/content/fusion1.html

www.bbc.co.uk/schools/gcsebitesize/science/add_aqa_pre_2011/radiation/nuclearfissionrev2.shtml

www.frankswebpace.org.uk/ScienceAndMaths/physics/physicsGCSE/nuclearFusion.htm

Star formation:

www.s-cool.co.uk/gcse/physics/space/revise-it/life-of-stars

www.gcse.com/eb/star1.htm

Past paper questions:

Nov 12 Paper 22 Q7

Nov 12 Paper 22 Q8

Nov 11 Paper 21 Q8

Jun 11 Paper 22 Q8

Nov10 Paper 22 Q7

11. The Nuclear Atom

GCE O Level Physics by Charles Chew, Unit 25, Pg No. (404-416)

Explaining Physics by Stephen Pople, Unit 8.10, Pg No. (357 -360)

Content

11.1 Atomic model

11.2 Nucleus

Learning outcomes

Candidates should be able to:

- describe the structure of the atom in terms of nucleus and electrons.
- describe how the Geiger-Marsden alpha-particle scattering experiment provides evidence for the nuclear atom.
- describe the composition of the nucleus in terms of protons and neutrons.
- define the terms proton number (atomic number), Z and nucleon number (mass number), A .
- explain the term nuclide and use the nuclide notation A_ZX to construct equations where radioactive decay leads to changes in the composition of the nucleus.
- define the term isotope.
- explain, using nuclide notation, how one element may have a number of isotopes.

Enhancement

- Describe how the scattering of α -particles by thin metal foils provides evidence for the nuclear atom
- Use the term isotope
- Give and explain examples of practical applications of isotopes

Reference Books

- Pople, Stephen, Fundamental Physics for Cambridge O level, Oxford University Press; Unit 10.09- 10.11, Pg No.(266–270)
- Rnold.BrianWoolley.Steve, Long man GCSE Physics Pearson education Ltd; Chap 31, Pg No 293
- Avison.John, The World Of Physics, Thomas Nelson & Sons Ltd; Chap 17, Pg No 380
- Sang, David, Physics 1 & 2, Cambridge University Press
- Duncan, Tom, GCSE Physics, John Murray
- Abbott, A.F., Physics, Heinemann Educational

Learning Resources:

Electrons:

www.aip.org/history/electron/

www.youtube.com/watch?v=ky1Awa0pJ0s

Atomic structure:

www.purchon.com/chemistry/atoms.htm

www.bbc.co.uk/schools/gcsebitesize/science/add_aqa_pre_2011/atomic/atomstrucrev1.shtml

www.youtube.com/watch?v=jRVjDKesnY4

The nuclear atom:

www.nuffieldfoundation.org/practical-physics/developing-model-atom-nuclear-atom

Protons and neutrons:

www.bbc.co.uk/schools/gcsebitesize/science/add_ocr_pre_2011/periodic_table/atomicstructure/rev1.shtml

Isotopes:

www.colorado.edu/physics/2000/isotopes/index.html

<http://hyperphysics.phy-astr.gsu.edu/hbase/nuclear/nucnot.html>

www.chem4kids.com/files/atom_isotopes.html

NOTE: The whole Syllabus of Class 9 & 10 also included.

Paper 4: Alternative to Practical Paper

This paper is designed for those Centers for whom the preparation and execution of the Practical Test is impracticable. The Alternative to Practical Paper consists of four or five questions relating to practical Physics: candidates answer on the question paper.

The best preparation for this paper is a thorough course in experimental Physics. Candidates are unlikely to demonstrate their full potential on this paper unless they have become fully familiar with the techniques and apparatus involved by doing experiments for themselves. Questions may involve the description of particular techniques, the drawing of diagrams, or the analysis of data. The examiners expect the same degree of detail as for Paper 3 and candidates should be taught to adopt practices which satisfy the same general marking points. In addition, candidates should be able to draw, complete and label diagrams of apparatus and to take readings from diagrams of apparatus given in the question paper. Where facilities permit, demonstration experiments by the teacher can be very useful in the teaching of particular techniques, and can be the source of useful data for candidates to analyse.

Notes on the Alternative to Practical Paper Paper 4

1. This paper is an alternative to a practical exam, not an alternative to a practical course.
2. The preparation for students is a well-designed practical course.
3. The course should teach candidates how to make measurements using many different types of instruments. They should see the instruments, handle them, discuss their scales and the scale units before using the instruments.
4. Students should understand why the choice of range for the measuring scale should match the size of the quantity being measured.
5. Students should be taught how to record measurements in a table. A table should record all the measurements needed to obtain the value of a given physical quantity.
For example if a length l is derived from $l = l_2 - l_1$ then l_1 and l_2 should appear in the table.
Columns (or rows) in the table should be headed with the name of symbol of the physical quantity. The unit in which the quantity is measured should be included. The SI method is recommended. Encourage neat work.
6. Ideally, when performing an experiment (and relevant readings are recorded) it is helpful to arrange the experiment so that one variable is increased step by step.
Candidates should always look for a trend in the recorded results. Some trends are
 - y increases as x increases
 - Straight line through the origin, if x is doubled then y is doubled, direct proportionality
 - y decreases as x increases

- $x \text{ times } y = k$, inversely proportionality. Inverse proportionality is generally not properly understood
7. A graph is the best way to display the results of an experiment.
 - y/unit against x/unit should be understood as the label of each axis
 - axes should
 - be labeled with quantity, unit and scaled
 - As large as possible, but should not use an awkward scale to achieve the size
 - Plotting should be neat and as accurate as possible
 - Graph lines should be neat, thin and a good fit (if there is scatter of points they should lie either side of the line{in a rough way!! }). Straight lines should FILL the page (even beyond the range of points) so that any gradient calculation can use the largest y and x . Students should understand why! (y is a measurement.)
 - Students should describe what information is obtained from a graph, see note 6.
 8. Students should understand the idea of a **fair test** or comparison in which only one variable is altered at a time, eg when investigating how rate of cooling experiment depends on temperature room to be kept constant--room draughts, volume and type of liquid, amount of stirring.
 9. Students should be trained to give a conclusion to an experiment.

10. Good procedures:

- Repeat to spot anomalous errors or to calculate an average
- Avoid making parallax errors, {the line of sight should be perpendicular to the reading on the scale}
- Make a note of the details of any scale that is used eg
 - The unit in which the scale is calibrated
 - The maximum reading that can be obtained
 - The smallest change in value that can be obtained
- Physical quantities
 - Aim to use quantities that have magnitudes that are towards the upper values of the scale
 - A unit must always be given with the magnitude of a quantity
- In experiments involving the measurement of a length
 - Try to use lengths that are at least 100 mm in length
 - Measure to the nearest mm, (so the "accuracy" in (a) is 1 in 100)
 - When measuring heights ensure that the rule is held perpendicular to the base
 - Use a fiducial aid
 - Know how to arrange apparatus so that it is parallel or perpendicular to a bench
- In light experiments using objects, lenses and a screen
 - Ensure that each item is aligned so that the centre of each item is at the same height and on the same horizontal straight line (ideally use the term optic axis)
 - Try to use distances that are at least 100 mm in length
 - Use a fiducial aid when measuring a length
 - Try to use a translucent screen
 - Perform the experiment in a shaded part of the laboratory
- In ray tracing experiments
 - When using marker pins space the pins so that they are at least 60 mm apart
 - Ensure that the pins are vertical
 - Draw neat thin lines
 - Use the largest angles available and draw the arms of the angle longer than the radius of any protractor being used, a large radius is desirable

- When using a thermometer
 - Position the eye so that the mercury thread appears to touch the scale
 - Attempt to interpolate the position of the meniscus on the scale ie read between the marks
 - Check whether the thermometer is full or 1/3 immersion
- In heat experiments
 - Choose volume/mass values of the quantities that give large changes in the Temperature
 - Insulate the container, cover the container, stir, wait for highest temperature
- In electrical experiments
 - Check for a zero error
 - Tap the meter to avoid sticking
 - Initially choose the highest range for the ammeter/voltmeter, then reduce the range for the ammeter so that the deflection is almost full scale
 - Always check polarities before closing the switch (completing the circuit)
 - Always check that connections are clean.
 - Switch off the current when not making a measurement.
- When measuring an interval of time
 - Choose a clock or stopwatch that will give 1% accuracy (e.g. 1 sec in 100 sec)
 - For oscillations (of a pendulum or vibrating rule), be able to define a complete oscillation; time N oscillations so that the total time is at least 100sec and use the terminology periodic time $T = t/N$; repeat the experiment so as to obtain an average of t ; explain how to use a fiducial aid at the centre of the oscillation; explain where the eye should be placed as to as to avoid parallax errors

Your Handy Checklist for the Practical:

1. Repeat all readings and average. Show all readings. If timing measure the period of at least 5 oscillations each time. Try for 10 if time allows. Remember timing error is 0.1s with a handheld stop clock. When taking a set of readings make sure that they cover the whole range of the readings fairly evenly.
2. Try to arrange for a single table which
 - shows all readings, even the first, and their averages
 - has the correct units and quantities for each column
 - has the same precision (ie no. of sig figs) for every reading in a particular column. Choose a sensible number of sig. figs. (Usually 2 or 3)
3. Your graph should
 - have each axis labelled with both quantity and unit
 - occupy at least 5x7 squares (ie half the paper) with **YOUR** plotted points
 - ask yourself whether the origin should be plotted
 - not use an awkward scale, ie 1 square = 3, 7, 9 units
 - have points plotted neatly, with NO large blobs, or crosses. Circle your points if you plot them as dots.
 - have a clear even thin line plotted
4. In measuring the slope
 - use at least half of the drawn straight line
 - show the coordinates that you use for the slope or the values of the sides of the triangle that you use.
 - give your answer to 1 or 2 sig. figs as appropriate. Don't forget units.
5. Know the straight line formula for a graph, $y = mx + c$,
 - If $y^2 = kx^3$ then plot y^2 against x^3 and the slope is k

- If $y = kx^n$ then plot $\log_{10}(y)$ or $\ln(y)$ against $\log_{10}(x)$ or $\ln(x)$ slope is n .
On tables and graphs the label is $\log_{10}(y/m)$ or $\ln(y/m)$ to show the unit of y as metres
Check that you know how to use logs.

Checking Relationships

In each case **state** what should be constant, perform the calculation and then say whether the constant was found and the relationship verified within the error.

- Y proportional to x Y/x should be constant
- Y proportional to $1/x$ Yx should be constant
- Y proportional to e^x Y decreases by same **factor** if x increases by equal amounts

Errors

1. Causes of error in simple measurements **LEARN THESE**

- **Lengths** rulers have battered ends, or the zero is not actually at the end
parallax error, you must view any reading from directly above.
likely error is +1 mm or perhaps + 0.3 mm
- **Times** stopwatches measure to + 0.01s but you can't press them that accurately,
likely error is + 0.1s.
- **Meters (eg ammeter)** error is the smallest scale reading, or notice any fluctuation.

2. Combining errors

- There are absolute errors and percentage errors
- Adding or subtracting quantities add absolute errors
- Multiplying or dividing quantities add percentage errors to get percentage error in answer

Work through this example then repeat it yourself on paper

If $A = 2.34 \pm 0.02$ and $B = 6.0 \pm 0.1$

(Notice the values are quoted to the no. of decimal places justified by the error)

$$A+B = 8.34 \pm 0.12 = 8.3 \pm 0.1$$

$$B-A = 3.64 \pm 0.12 = 3.6 \pm 0.1$$

$$B/A = 2.56 \text{ \% error} = \text{\%error in A} + \text{\%error in B}$$

$$= 1 \quad + \quad 1.5$$

$$= 2.5\%$$

$$\text{Actual error in } B/A = 2.56 * 2.5/100 = 0.06$$

$$\text{So } B/A = 2.56 \pm 0.06$$

$$B.A = 14.04, \text{ again to } 2.5\%, \text{ which is } 2.5 * 14.04/100 = 0.4$$

$$B.A = 14.0 \pm 0.4$$

Describing and improving an experiment

State every reading you will take. Do not say "Take the readings as before". Make clear what is kept constant and what is changed. Give sensible values for quantities, particularly those that are changed. Use your common sense. Have at least five sets of readings as a variable changes. Say that you will repeat and average each reading. Say what the axes will be for a straight line graph. Never just say "plot a graph". Set out your account clearly and logically; use their suggested format if you think it helps. Plan your account briefly before you start writing.

Glossary of Terms Used

The glossary will prove helpful to students as a guide but it is not exhaustive. The glossary has been deliberately kept brief, not only with respect to the numbers of terms included but also to the descriptions of their meanings. Students should appreciate that the meaning of a term must depend, in part, on its context.

1. Define (the term(s) ...) is intended literally. Only a formal statement or equivalent paraphrase, such as the defining equation with symbols identified, being required.
2. Explain/ What is meant by ... normally implies that a definition should be given, together with some relevant comment on the significance or context of the term(s) concerned, especially where two or more terms are included in the question. The amount of supplementary comment intended should be interpreted in the light of the indicated mark value.
3. State implies a concise answer with little or no supporting argument, e.g. a numerical answer that can be obtained 'by inspection'.
4. List requires a number of points with no elaboration. Where a given number of points is specified, this should not be exceeded.
5. Describe requires candidates to state in words (using diagrams where appropriate) the main points of the topic. It is often used with reference either to particular phenomena or to particular experiments. In the former instance, the term usually implies that the answer should include reference to (visual) observations associated with the phenomena. The amount of description intended should be interpreted in the light of the indicated mark value.
6. Discuss requires candidates to give a critical account of the points involved in the topic.
7. Deduce implies that candidates are not expected to produce the required answer by recall but by making a logical connection between other pieces of information. Such information may be wholly given in the question or may depend on answers extracted in an earlier part of the question.
8. Suggest is used in two main contexts. It may either imply that there is no unique answer or that candidates are expected to apply their general knowledge to a 'novel' situation, one that formally may not be 'in the syllabus'.
9. Calculate is used when a numerical answer is required. In general, working should be shown.
10. Measure implies that the quantity concerned can be directly obtained from a suitable measuring instrument, e.g. length, using a rule, or angle, using a protractor.
11. Determine often implies that the quantity concerned cannot be measured directly but is obtained by calculation, substituting measured or known values of other quantities into a standard formula, e.g. the Young modulus, relative molecular mass.

12. Show is used when an algebraic deduction has to be made to prove a given equation. It is important that the terms being used by candidates are stated explicitly.
13. Estimate implies a reasoned order of magnitude statement or calculation of the quantity concerned. Candidates should make such simplifying assumptions as may be necessary about points of principle and about the values of quantities not otherwise included in the question.
14. Sketch, when applied to graph work, implies that the shape and/or position of the curve need only be qualitatively correct. However, candidates should be aware that, depending on the context, some quantitative aspects may be looked for, e.g. passing through the origin, having an intercept, asymptote or discontinuity at a particular value. On a sketch graph it is essential that candidates clearly indicate what is being plotted on each axis. Sketch, when applied to diagrams, implies that a simple, freehand drawing is acceptable: nevertheless, care should be taken over proportions and the clear exposition of important detail.

Formulae for Relationships between Physical Quantities:

The relationship below will not be provided for candidates either in the form given or in rearranged form.

the relationship between speed, distance and time:

$$\text{speed} = \text{dis}/\text{time}$$

the relationship between force, mass and acceleration:

$$\text{force} = \text{mass} \times \text{acceleration}$$

$$\text{acceleration} = \text{change in velocity} / \text{time}$$

the relationship between density, mass and volume:

$$\text{density} = \text{mass} / \text{volume}$$

the relationship between force, distance and work:

$$\text{work done} = \text{force} \times \text{distance moved in direction of force}$$

the energy relationships:

$$\text{energy transferred} = \text{work done}$$

$$\text{kinetic energy} = \frac{1}{2} \times \text{mass} \times \text{speed}^2$$

$$\text{change in potential energy} = \text{mass} \times \text{gravitational field strength} \times \text{change in height}$$

the relationship between mass, weight and gravitational field strength:

$$\text{weight} = \text{mass} \times \text{gravitational field strength}$$

the relationship between an applied force, the area over which it acts and the resulting pressure:

$$\text{pressure} = \text{force} / \text{area}$$

the relationship between the moment of a force and its distance from the pivot:

$$\text{moment} = \text{force} \times \text{perpendicular distance from pivot}$$

the relationships between charge, current, voltage, resistance and electrical power:

charge = current × time

voltage = current × resistance

electrical power = voltage × current

the relationship between speed, frequency and wavelength:

wave speed = frequency × wavelength

the relationship between the voltage across the coils in a transformer and the number of turns in them:

voltage across secondary = number of turns in secondary

voltage across primary = number of turns in primary

Summary of key quantities, symbols and units:

Candidates should be able to state the symbols for the following physical quantities and, where indicated, state the units in which they are measured. Candidates should be able to define the items indicated by an asterisk (*).

Quantity	Symbol	Unit
length	<i>l, h ...</i>	km, m, cm, mm
area	<i>A</i>	m ² , cm ²
volume	<i>V</i>	m ³ , cm ³
weight	<i>W</i>	N*
mass	<i>m, M</i>	kg, g, mg
time	<i>t</i>	h, min, s, ms
density*	<i>ρ</i>	g/cm ³ , kg/m ³
speed*	<i>u, v</i>	km/h, m/s, cm/s
acceleration	<i>a</i>	m/s ²
acceleration of free fall	<i>g</i>	
force*	<i>F, P ...</i>	N
moment of force*		Nm
work done	<i>W, E</i>	J*, kWh*
energy	<i>E</i>	J
power*	<i>P</i>	W*
pressure*	<i>p, P</i>	Pa*, N/m ²
atmospheric pressure		use of millibar
temperature	<i>θ, t, T</i>	°C
heat capacity	<i>C</i>	J/°C
specific heat capacity*	<i>c</i>	J/(kg °C), J/(g °C)
latent heat	<i>L</i>	J
specific latent heat*	<i>l</i>	J/kg, J/g
frequency*	<i>f</i>	Hz
wavelength*	<i>λ</i>	m, cm

Quantity	Symbol	Unit
focal length	f	m, cm
angle of incidence	i	degree (°)
angles of reflection, refraction	r	degree (°)
critical angle	c	degree (°)
potential difference*/voltage	V	V*, mV
current*	I	A, mA
charge		C, As
e.m.f.*	E	V
resistance	R	Ω

Resource List:

- Breithaupt, J Key Science – Physics (Stanley Thornes)
- Dobson, K The Physical World (Nelson)
- Duncan, T GCSE Physics (Third edition) (John Murray)
- Nuffield Co-ordinated Sciences Physics (Longman)
- Avison, John, The World of Physics, Thomas Nelson & Sons Ltd
- Arnold, Brain, Longman GCSE Physics, Pearson education ltd

Websites:

- www.focuseducational.com
- www.crocodile-clips.com